Chapter 11

PRE- AND POST-PLANT NUTRITION

Version 1, 1 Feb 2006

N.B. This chapter should be read in conjunction with the chapter on essential pineapple nutrients.

Pre-plant nutrition

Soil analysis

Soil analysis is the first step in a fertiliser program. Soil samples should be taken at least six weeks (earlier if major imbalances are suspected) prior to planting to allow time for analysis, interpretation and application of corrective treatments before bed preparation.

Soil analysis results allow appropriate pre-plant rates of required ameliorants and fertilisers to be determined. This is particularly important for soil pH and levels of the less soluble nutrients so that materials can be applied, worked into the soil and have time to start correcting the soil chemistry before planting. Ameliorants such as lime, dolomite or sulphur for pH correction are best incorporated several months prior to planting. Also, if levels of nutrients, particularly potassium, are in the optimum range early in crop growth then this avoids difficult balancing problems later.

Refer to the chapter on monitoring for details on the sampling process.

Managing soil pH

Note: The soil pH levels referred to in this chapter are the levels measured in <u>water</u> (not in calcium chloride, CaCl).

In most Queensland situations the optimum soil pH range for pineapple lies between 4.5 – 5.6, however they have been grown successfully in a range between 4.0 – 6.3. The optimum range is a compromise between the best for nutrient availability (about pH 6.5) and the most favourable for suppressing *Phytophthora* rot (below pH 4). If *Phytophthora* pressure is high (e.g. in cooler areas that receive high rainfall and have less than optimum soil drainage) then aim towards the lower end of the suggested range.

pH too low

If the soil pH is below 4.5 then a suitable rate of lime or dolomite must be calculated from the soil analysis data then broadcast and incorporated several weeks or months before planting. The calcium and magnesium levels in the soil and their ratio (should be about 4 Ca: 1 Mg) are used to decide whether lime (calcium carbonate) or dolomite (calcium and magnesium carbonates) should be used.

pH too high

Soil pH is seldom too high in Queensland but if this is the case the options are:

a. Marginally too high: a standard fertiliser program using chemical fertilisers e.g. ammonium sulphate and urea will gradually lower soil pH over time. Do not apply rates greater than those required to meet the crop nutrient needs.

b. Significantly too high (e.g. sites of lime dumps, chicken manure heaps, where timber stacks have been burnt): elemental sulphur (S) (“flowers of sulphur”) can be evenly spread and incorporated to a depth of 15cm where it will react slowly with the soil in the presence of organic matter and moisture. It is difficult to spread evenly because it is fine and light, it is also a skin and lung irritant so for large areas it is advisable to engage a specialist contractor. The following rates are given as a guide:

    i. On sandy soils (sands, loamy sands and sandy loams) – rates of 300 kg S/ha will reduce soil pH by about one unit.

ii. On loams and silty loams – rates of 1 tonne S/ha will reduce soil pH by about one unit.

iii. On clay soils – rates of 1.5 tonnes S/ha will reduce soil pH by about one unit.

Correcting nutrient deficiencies and imbalances

The soil should be topped up with the major nutrients no later than planting, as determined by soil analysis (see Table 1). It is important that this is achieved so that (a) the crop has an adequate supply of nutrients for early growth and (b) nutrients are balanced in the soil.

Table 1. Desired soil nutrient levels at planting time (adapted from Broadley et al., 1993).

Nutrient	Desired soil nutrient level at planting time (ppm)
Nitrogen (N)	27
Nitrate (NO_3^-)	120
Phosphorus (P)	25+
Potassium (K)	150 (0.4 meq/100g)
Calcium (Ca)	more than 100 (0.5 meq/100g)
Magnesium (Mg)	more than 50 (0.4 meq/100g)
Zinc (Zn)	3+
Copper (Cu)	2+

Correction of deficiencies before planting is particularly important for calcium (Ca) and phosphorous (P) which are difficult to correct during plant growth, and for copper (Cu) which is toxic as a foliar spray in most common forms except expensive copper chelates.

Refer to Table 3 for recommended amounts of N, P & K required in the soil pre-plant.

The crop's full requirements for N, K and Mg are not all supplied pre-plant because losses occur from the soil over the course of the growing cycle due to leaching and denitrification. N, K and Mg, and sometimes small amounts of Fe and Zn are applied as foliar sprays and/or side-dressings in split applications through the growing period until induction. B is applied with the induction spray. Table 3 shows typical needs.

Calcium (Ca), magnesium (Mg) and potassium (K) balance

K applications depress the level of Ca and Mg in the plant tissue, so it is better to ensure Ca, Mg and K are at optimum levels in the soil from the start. Pineapple requirement for Mg is higher than Ca and with the tendency to strive for high K levels early in plant growth the balance between Mg and K can be easily upset. Ca levels tend to drop in winter even under the best conditions, but excessive applications of K can make this worse.

To keep Mg and K in balance always apply Mg as magnesium sulphate (Epsom salts) in K sprays in the ratio of 1kg of magnesium sulphate:10kg potassium sulphate.

Managing soil organic matter

Higher soil organic matter content improves the nutrient and moisture holding capacity and structure of the soil. However it is very difficult to sustain an increase in soil organic matter especially since good soil tilth with an absence of plant residue is required for bed preparation and efficient pesticide use. The following practices can help maintain or slightly increase organic matter in a pineapple field:

1. Pre-plant application of mill mud (from sugar mills) or composted animal manures at about 10 t/ha.

2. Growing green manure crops then ploughing them into the topsoil prior to bed preparation.

3. Minimum tillage practices can reduce the loss (oxidation) of organic matter.

When organic amendments are used, the nutrient content of these materials must be accounted for in the total crop nutrient budget.

NB. It is important to bear in mind that the release of nutrients from organic materials will occur over a longer time period and is less predictable than from chemical fertilisers. Therefore there is a danger that significant nitrogen release may occur at a point in the pineapple's growth cycle that is inappropriate, e.g. after initiation, posing an excess fruit nitrate hazard.

Post plant nutrition

The emphasis here should be to maintain a fertiliser program that:

1. is adjusted according to the results of a regular leaf testing program

2. takes into account the type of crop (e.g. spring plant crop), the stage in the crop's cycle and seasonal conditions (e.g. drought, winter temperatures).

Leaf analysis

For the plant crop, leaf analysis should be done 4 to 6 months after planting and again at 9 months after planting. In the ratoon crop, leaves should be sampled 3 months after plant crop harvest. Leaf analysis will indicate if any corrective nutrient applications or adjustment in the fertilising schedule are required. Leaf samples can be taken at monthly intervals up to induction, but usually less frequent sampling is satisfactory once you have gained some experience in how your crops respond.

Refer to the chapter on monitoring for details on the sampling process.

Table 2 shows the leaf nutrient levels considered to be optimum.

Table 2. Leaf nutrient levels considered adequate at induction.

Note: When the Golden Circle Ltd laboratory performed the analyses results were expressed on a fresh weight basis, now that the analyses are out-sourced to Incitec/Pivot the results are expressed on a dry weight basis

Element	Adequate leaf level	
	FRESH weight basis of D-leaf basal white tissue	**DRY weight basis of D-leaf basal white tissue**
Nitrogen (N)	N leaf levels in pineapple too erratic to be useful, leaf colour used instead	
Phosphorus (P)	200 ppm (0.02%)	0.14 – 0.35%
Potassium (K)	3 000 ppm (0.3%)	4.3 – 6.4%
Calcium (Ca)	150 ppm (0.015%)	0.22 – 0.4%
Magnesium (Mg)	250 – 270 ppm (0.025-0.027%)	0.41 – 0.57%
Sulphur (S)	Not known	Not known
Chlorine (Cl)	Not known	0.2 - 0.8% (middle third of D-leaf)
Sodium (Na)	Not known	0.004 – 0.015%
Iron (Fe)	Not known, unreliable	80-150 ppm suggested but unreliable, leaf symptoms used instead of analysis in Qld
Zinc (Zn)	3+ ppm but not used, too difficult to analyse for	15-70 ppm suggested but leaf symptoms used instead of analysis in Qld
Copper (Cu)	Not known	10-50 ppm
Boron (B)	Not known	Not known
Manganese (Mn)	Not known	150-400 ppm

Matching fertiliser rates to growth rates

The rates of fertiliser maintenance dressings should be adjusted to match the growth rate of the plants and environmental conditions.

The two diagrams below illustrate how the growth rates of two different crops can be so different during the same months of the year because of the different stages the crops are at. The fertiliser needs at any one point in time during a normal season are determined by the growth rate and this is governed by a combination of (a) the stage in the growth cycle and (b) the potential growth rate as determined by temperature.

The suggested fertiliser schedules included towards the end of this chapter reflect the needs of different crops over their development as determined by the different stages of growth cycle and the expected temperatures during these stages during normal seasons.

Superimposed on these expected growth rates are unpredictable environmental conditions such as drought, leaching rain and severe pest or disease attack on the root system. The fertiliser schedules need to be adjusted to accommodate these events. For example nitrogen rates need to be cut back during drought to prevent waste, potential environmental problems and high fruit nitrate.

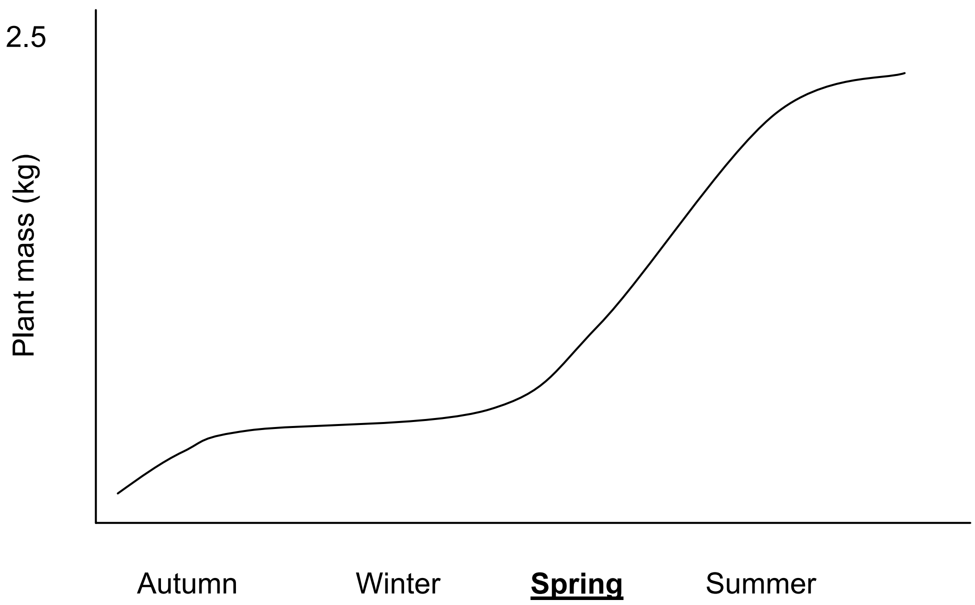

Figure 1. Graph showing the growth rate of a summer plant crop

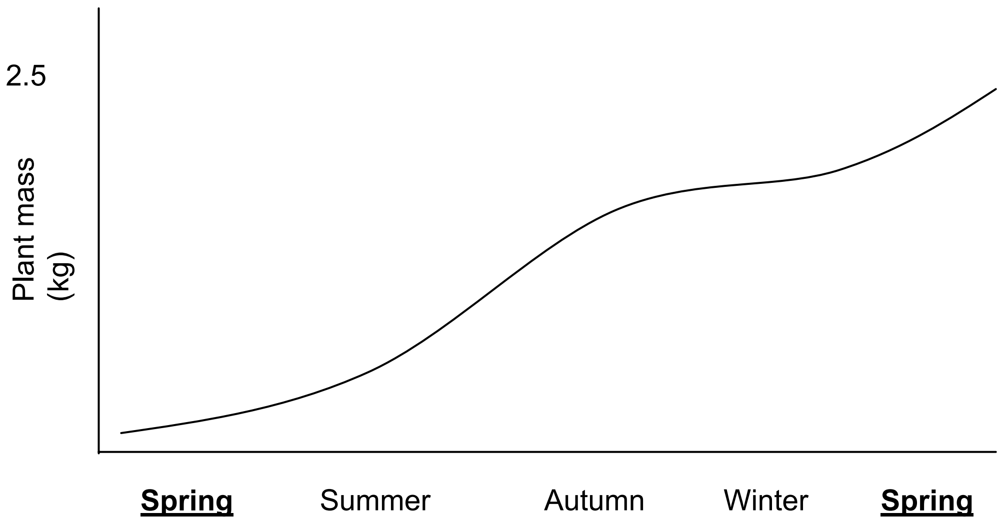

Figure 2. Graph showing the growth rate of an autumn plant crop

Side dressing vs. foliar fertiliser applications

Side dressing

Side dressing often suits the labour requirements of the farm because two or three months of fertiliser can be put on in one application, whilst with a boom spray applications need to be applied at least once per month except in winter. However with side dressing there is a risk of losing large amounts of fertiliser to heavy rainfall thus wasting money and posing an environmental hazard. Also, in dry conditions side dressed fertiliser not yet rained into the soil is unavailable to the plant. When it does eventually rain however the plant may receive an overdose which in the case of nitrogen can lead to excessive fruit nitrate.

Foliar fertiliser

Foliar fertilisers are applied in small amounts and often so only relatively small doses can be lost to heavy rainfall. Also, during dry weather much of the fertiliser applied is available to the plant because it is applied with a significant volume of water which runs down the leaves into the leaf axils where the water and nutrients are absorbed by the aerial roots.

Summary of plant and ratoon crop needs

Table 3. Summary of typical nutritional requirements of plant and ratoon crops

Nutrient	**Needed in soil pre-plant (kg/ha)**	**Plant Crop (kg/ha)**	**Ratoon Crop (kg/ha)**	**Total cycle (kg/ha)**
	(units are kg of element unless specified otherwise)			
Nitrogen (N)	120	450-480	300-340	**870-940**
Phosphorus (P)	50-100	Up to 25 (max) on P fixing soils	Up to 25 (max) on P fixing soils	**50-100**
Potassium (K)	300	475-535	160-280	**935-1120**
Calcium (Ca)	As determined by soil analysis	-	-	
Magnesium (Mg)	As determined by soil analysis	12	6	
Sulphur (S)	Adequate amounts provided in sulphate based fertilisers			
Iron (Fe)	-	1% sprays of ferrous sulphate if required	1% sprays of ferrous sulphate if required	**25-35**
Zinc (Zn)	30 kg $ZnSO_4$ on new soil	4-6 if required	4-6 if required	**8-12+**
Boron (B)	-	2-6 at induction	2-6 at induction	**4-8**
Copper (Cu)	30 kg $CuSO_4$ on new soil	-	**-**	
Manganese (Mn)	Only if required	**-**	**-**	
Molybdenum (Mo)	Only if required	**-**	**-**	

A plant crop requires about 600 kg/ha of nitrogen and about 800 kg/ha of potassium. These rates include the amounts already in the soil, as determined by the soil analysis, and the amounts, including organic amendments, applied prior to planting.

The amounts of fertiliser applied during the crop's growth must be varied according to the leaf analysis results, plant size, crop cycle, and season (i.e. how wet or dry it is).

In general, the crop needs more K during early growth and more N towards induction. Tapering off N applications from about one month prior to induction will reduce the vegetative growth rate and improve the chances of a successful induction. K and Mg compete with each other in the soil and plant, so do not apply excessive K otherwise Mg deficiency will be induced.

The ratoon crop develops over a shorter period, and depends very much on the health of the parent crop. Its fertiliser requirements are lower than those of the plant crop, but otherwise are fairly similar. Here again the rates should be adjusted according to leaf analysis results, plant size, crop cycle and season.

Suggested fertiliser schedules

The three tables below show some examples of fertiliser schedules which may be recommended in particular situations. These may be useful for assisting you to plan your own schedules, but you should vary these in accordance with leaf analysis results, soil type, climate and your own experience. For instance, a heavy soil with a high nitrogen level might need less N, but a light sandy soil subject to leaching might need more. Don’t forget to take a soil sample during land preparation to guide you in satisfying soil nutrient levels before planting especially Ca, P and Cu.

Note: These schedules are examples only to illustrate how applications are linked to crop size and season on average soil. Your own applications should take into account your local conditions, current season and style of management.

References and further reading

Broadley, R.H., Wassman, R., Sinclair, E. (1993). *Pineapple pests & disorders*. DPI.

Reuter R.J. and Robinson J.B. (1986). Plant analysis - an interpretation manual. Inkata Press P/L. 218 p.

Scott, Col (1993) Current fertiliser systems in pineapples. *Nutrition in horticulture. Proceedings of a review workshop. Gatton.*

Sinclair, Eric (1994) Leaf and soil analysis. *Pineapple industry field day notes*, 45-54.

Sinclair, E. (1999) Suggested schedules for fertilising pineapples. *Golden Circle Ltd.*

SPRING PLANT CROP – Example of boom spray applications of major elements				
Pre-Plant - N - make soil level up to 120 kg N/ha - K, Mg & Ca - make up soil levels according to soil analysis				
			kg/ha of product	
Month	**Operation**	**Urea**	**Potassium sulphate**	**Magnesium sulphate**
December	Planting		Pre-plant as above	
January				
February			50	5
March		30	100	10
April		30	100	10
May	***Leaf sample***	40	100	10
June		40	50	5
July		20	25	5
August		40	50	5
September	***Leaf sample***	60	100	10
October		100	150	15
November		120	150	15
December		170	200	15
January		180	200.	20
February	Induction	220		
March		Total = 1050 kg urea	Total = 1275 kg pot.sulphate	Total = 125 kg mag.sulphate
April		**= 480 kg N/ha**	**= 520 kg K/ha**	**= 12 kg Mg/ha**
May				
June				
July				
August				
September				
October	Harvest			
November				
December		20	50	5
January	***Leaf sample***	40	50	5
February		40	100	10
March		40	100	10
April		40	50	5
May		40	50	5
June		20	25	5
July		20	25	5
August		40	50	5
September		80	50	5
October		120	50	10
November	Induction	220		
December		Total = 720 kg urea	Total = 600 kg pot.sulphate	Total = 70 kg mag.sulphate
January		**= 330 kg N/ha**	**= 250 kg K/ha**	**= 7 kg Mg/ha**
February				
March				
April				
May				
June	Harvest			

SUMMER PLANT CROP – Example of boom spray applications of major elements

Pre-Plant - N - make soil level up to 120 kg N/ha
- K, Mg & Ca - make up soil levels according to soil analysis

Month	Operation	Urea	kg/ha of product Potassium sulphate	Magnesium sulphate
December				
January				
February			Pre-plant as above	
March	Planting			
April				
May				
June				
July				
August	***Leaf sample***		50	5
September			100	10
October		40	100	10
November		80	100	10
December	***Leaf sample***	90	100	10
January		110	125	10
February		130	150	15
March		140	150	15
April		140	150	15
May		140	100	10
June	Induction (once)	110		
July		Total = 980 kg urea	Total = 1125 kg pot.sulphate	Total = 110 kg mag.sulphate
August		**= 450 kg N/ha**	**= 460 kg K/ha**	**= 11 kg Mg/ha**
September				
October				
November				
December				
January				
February	Harvest			
March		80	100	10
April		80	100	10
May	***Leaf sample***	60	50	5
June		60	25	5
July		30	25	5
August		60	50	5
September		80	50	5
October	Induction	220		
November		Total = 670 kg urea	Total = 400 kg pot.sulphate	Total = 45 kg mag.sulphate
December		**= 310 kg N/ha**	**= 160 kg K/ha**	**= 4 kg Mg/ha**
January				
February				
March				
April				
May	Harvest			

APRIL PLANT CROP – Example of boom spray applications of major elements				
Pre-Plant - N - make soil level up to 120 kg N/ha - K, Mg & Ca - make up soil levels according to soil analysis				
			kg/ha of product	
Month	**Operation**	**Urea**	**Potassium sulphate**	**Magnesium sulphate**
July	Planting		Pre-plant as above	
August				
September			50	5
October			50	5
November		40	100	10
December	***Leaf sample***	80	100	10
January		80	100	10
February		80	100	10
March		120	150	15
April	***Leaf sample***	120	150	15
May		100	150	10
June		80	100	10
July		40	50	5
August		120	100	10
September	Induction (once)	110		
October		Total = 970 kg urea	Total = 1200 kg pot.sulphate	Total = 115 kg mag.sulphate
November		**= <u>450 kg N/ha</u>**	**= <u>500 kg K/ha</u>**	**= <u>11 kg Mg/ha</u>**
December				
January				
February				
March				
April	Harvest			
May		40	100	10
June		30	50	5
July	***Leaf sample***	30	50	5
August		40	50	5
September		60	100	10
October		80	100	10
November		100	100	10
December		100	120	10
January	Induction	220		
February		Total = 700 kg urea	Total = 670 kg pot.sulphate	Total = 65 kg mag.sulphate
March		**= <u>320 kg N/ha</u>**	**= <u>280 kg K/ha</u>**	**= <u>6 kg Mg/ha</u>**
April				
May				
June				
July				
August				
September	Harvest			

Appendix I. Nutrient content of common fertilisers

Fertiliser	N%	P%	K%	Ca%	Mg%	S%	B%	Fe%	Zn%	Cu%	Cl%
Urea	46										
Ammonium nitrate (permit reqd)	34										
Sulphate of ammonia	20.5					24					
Incitec CK77S	13.3	2.2	13.5			19.6					
Growforce GF 301	13.2	14.7	13.2			1.2					
Nitrophoska Blue Spec.	12	5.2	14.1	4.3	1.2	6					
MAP	10	21.9				1.5					
MAP tech. grade (for sprays)	12	26.6									
DAP	18	20				1.6					
Superphosphate		8.8		20		11					
Triple superphosphate		20.4		14.6		1					
Muriate of potash			50								50
Sulphate of potash			41			18					
K-Mag (Sulpomag)			18.2		11.1	22					
Cal-Mag				32	8						
GrowMag				12.8	4.8						
Granomag					54						
Magnesium sulphate					9.6	12.4					
Gypsum				18.5		14.5					
Calcium carbonate (talc)				35							
Ag. lime				33							
Dolomite				14	8						
Magnesium lime				29	2.3						
Borax							11				
Solubor							20.5				
Copper sulphate						12.6				25	
Ferrous sulphate						11		20			
Zinc sulphate						10.5			22		

NOTE: The nutrient content of these fertilisers may vary slightly from this data, especially the various grades and types of lime; check the label on the bag for specific details.

Appendix II. Guide to compatibilities of soluble fertilisers

(adapted from “Protect Your Pineapples”, 1993)

Note: This is a guide only; always try small quantities first when using new brands or types of fertilisers.

													Use	Remarks	kg of this fertiliser required for 1 kg of nutrient element
Urea ---													N	Normal foliar. 46%N	2.2
+	Ammonium nitrate (only available under permit)---												N	Alternate foliar. 34%N. Can be phytotoxic.	2.9
+	+	Ammonium sulphate ---											N	Rare foliar. 20.5%N. Expensive source.	4.8
+	+	+	Diammonium phosphate (DAP) ---										N, P	Foliar. 18%N, 20%P. If soil P inadequate.	5.5 for N, 5 for P
+	+	+	+	Monoammonium phosphate (MAP) ---									N, P	Foliar. Tech. grade: 12%N, 27%P.	8.3 for N, 3.7 for P
+	+	+	+	+	Potassium sulphate---								K	Normal foliar K. 41%K.	2.4
+	+	+	+	+	+	Potassium nitrate ---							N, K	Alternate foliar K. 13%N, 38%K. Can burn plants.	7.7 for N, 2.6 for K
+	+	-	-	-	-	+	Calcium nitrate---						N, Ca	Foliar. 15.5%N, 18%Ca. Rarely used.	6.5 for N, 5.6 for K
+	+	+	+	+	+	+	+	Borax ---					B	11% B. Usually applied with forcing.	9.1
+	+	+	+	+	+	+	+	+	Copper chelate ---				Cu	Foliar. 6% Cu.	Follow label instructions
+	+	+	-	-	+	+	-	-	+	Iron sulphate ---			Fe	Normal foliar. 20%Fe. Use with urea.	5
+	+	+	+	+	+	+	-	+	+	+	Magnesium sulphate---		Mg	Normal foliar (Epsom salt). 10% Mg.	10
+	+	+	-	-	+	+	-	-	+	+	+	Zinc sulphate ---	Zn	Normal foliar. Use with urea. 22% Zn.	4.3

Symbols

+ Compatible – will mix together in spray tank, and be effective when applied together.

- Incompatible – will not mix together (chemical or physical incompatibility), or not effective when applied together.

Notes

Notes